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# Data collection and analysis using the mobile application for environmental monitoring

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**Abstract**

This paper considers the analysis of problems and methods of implementation of information systems for monitoring natural and industrial facilities. The new approach of data storage, integration and retrieval developed. The practical applicability confirmed through experience in the development of information systems for the processing and analysis of spatial data using a mobile application.


Peer-review under responsibility of the Conference Program Chairs
*Keywords:* Mobile application, information system, Arduino, environmental monitoring system

## 1. Introduction

Thanks to the development and improvement of electronics, microelectronics, digital systems, microcontrollers, robotics, information technology and other directions, one can see the rapid development of information systems and mobile applications for control and monitoring. One of the contributing factors is - an electronic designer and convenient platform to the rapid development of electronic devices - Arduino[1-11]. The platform is very popular all over the world thanks to the convenience and ease of programming language, as well as because of open architecture and software code, which is used in different technical domains [5-12, 14-17].

Currently, the number of technological, environmental, personal sensors as personal portable device increased enough. These sensors can be used to measure the quality of air, the temperature level of carbon dioxide or toxic substances in the air, humidity, etc. These devices are small in size and are additionally equipped with Bluetooth and Wi-Fi, which allows analyzing the collected data and compare them with previously stored information [1-5, 7, 12-14, 18].

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However, the problem of air quality for cities with a population of 1 million or more, need to be analyzed more detailed, as the climatic conditions characterized by excessive accumulation of the metropolis of pollutants in the atmospheric surface layer, which leads to the formation of smog. As it is known in calm weather or poor natural ventilation air pollution has a more negative impact on the health of the population and it is the most pressing environmental issue requiring urgent solutions [15].

Based on the mentioned problems, the need for the development of information systems (IS) for control and environmental monitoring (EM).

In this paper, we have developed the mobile software for EM carried out with the help of mobile device (MD), which allows you to monitor the status of the system, to assess the extent to which certain actions from the perspective of compliance as outlined previously mentioned plans, and from the standpoint of achievement. In case of deviations from the parameters of the state should be taken to eliminate or other measures to ensure the safety.

In this paper, to solve a specific problem, we proposed EM IS, which consists of the devices based on the Arduino with the possibility to obtain information about the environment through a variety of sensors and can be controlled by various actuators. One of the main advantages of Arduino is that the devices are programmed via USB without device programmers[1].

Considered ES system is developed for students, lovers of design of systems and devices, as an example of practical implementation, with a view to its improvement in the future. In addition in our ES we applied free cloud-based service for the Android applications, called Parse.

## 2. Sensors and their main characteristics

The development of IS requires equipments, sensors and details, which are presented in Fig. 1. Ease of use of sensors and their basic advantages over other sensors are concludes in their simplicity and lower price, which is useful for construction the system for ES (there is no need to solder the connection).

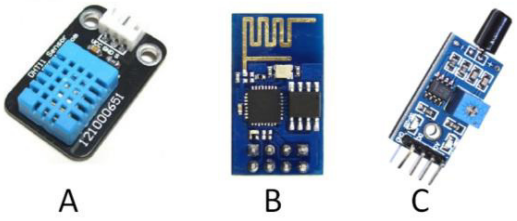


Fig. 1. Sensors: A - Temperature Sensor, B - Wi-fi module, C - Vibration sensor

1. Temperature Sensor Fig 1. A
Technical Specifications of Temperature Sensor[17] (see Fig 1. A and Table 1):

Table 1. Technical Specifications of Temperature Sensor.

| Item | Measurement Range | Humidity Accuracy | Temperature Accuracy | Resolution | Package |
|---|---|---|---|---|---|
| DHT11 | 20-90%RH<br>0-50 ℃ | ±5%RH | ±2℃ | 1 | 4 Pin Single Row |

2. Wi-fi module, ESPRESSIF SMART CONNECTIVITY PLATFORM: ESP8266EX. Espressif Systems' Smart Connectivity Platform (ESCP) is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers[6]. Fig 1. B
3. Vibration sensor (digital + analog outputs) with sensitivity[19]. Fig 1. C
4. Arduino Uno[1] (see Fig. 2.)


Fig. 2. Front of the Arduino Uno

Diagram presented in Fig. 3. illustrates the connection of the temperature sensor to the testing sketch. Connect data to pin 2, so it can be changed later to any pin.

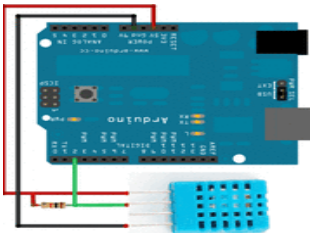

Fig. 3. Connection diagram of temperature sensor to the Arduino.

Using these sensors it is possible to construct a system to collect and analyze the data in real time, for example, temperature, carbon dioxide levels or toxic substances in the air, etc. The connection diagrams of sensor are presented in different works [5, 16, 20-22].

## 3. Software and information system structure

Depending on the tasks assigned to the IS, the structure and the software of the IS will change, and possibly methods of collecting, processing and storage of the data as well. The structure of the information system is essential to ensure the effective management of information resources. The structure of IS helps to identify some elements that complicate the passage of information flows and increase the risk of information loss, which has a negative impact on the quality of the functioning of IS.

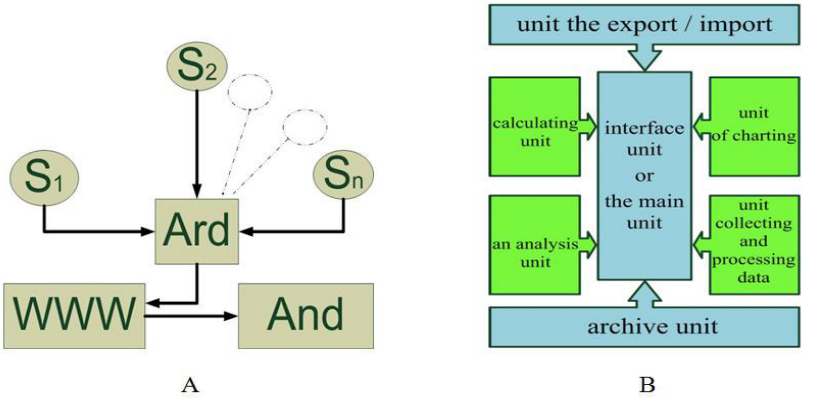


Fig. 4. Structure of IS (A) and structure of mobile software (B).

The structure of the software and information system allows both users and developers to understand the operation of IS, determine the number of its elements and learn what kind of details it consists.

## 4. Data collection and analysis methods

Analyzing the different works [2, 5, 8-12, 23] were revealed methods of collecting and processing data received from the information system, which can be used to monitor the state of the environment. The following methods of measurements and observations were studied:

- Stationary
- Mobile
- Remote

Each of these methods has their advantages and disadvantages, depending on the need to control the parameters, the number of parameters, environment, use of devices, information system, etc.

- Nowadays many the EM systems and services were developed. Let us present some of them: ReliaSENS 18-12 is a compact, easy to install environment monitor system that allows to collect and analyze air quality parameters, electromagnetic fields, ionizing radiation levels and (optionally) sound pollution [16].
- Poseidon2 4002 is a system for remote monitoring of rack environmental conditions (occupies 1U). Measures temperature, checks if the lights are on or the doors are open in the server room, and more. Relay outputs (4x digital output) can activate fans or an additional light. Poseidon is SNMP compatible, includes a data logger, e-mail and SMS alerts. It can be connected to the SensDesk online portal or cloud sensor systems[23].
- In the project WISE-MUSE was developed a mobile application that allows users to continuously monitor the environment and be aware of any undesirable changes that may occur in the museum[12]. The client-server architecture of the system is presented in Fig. 5.

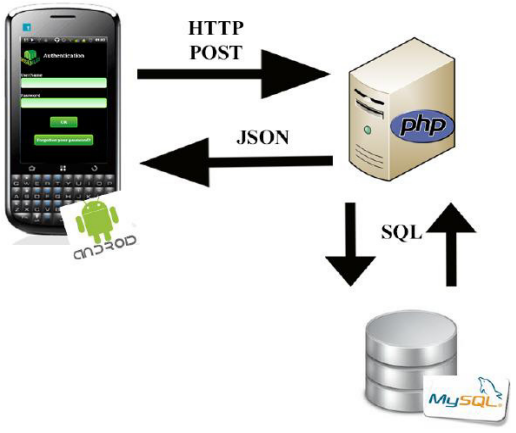


Fig. 5. Client-server architecture of the WISE-MUSE mobile application [12].

In contrast to the listed EM systems, the developed in this paper EM IS has the structure of software and IS, which allows to construct an equivalent system for each user without special knowledge and effort to obtain, process and store data about environment states.

## 5. Development of a database for mobile application

In this paper, as a database, we applied a cloud. The application sends data from any platform[24].

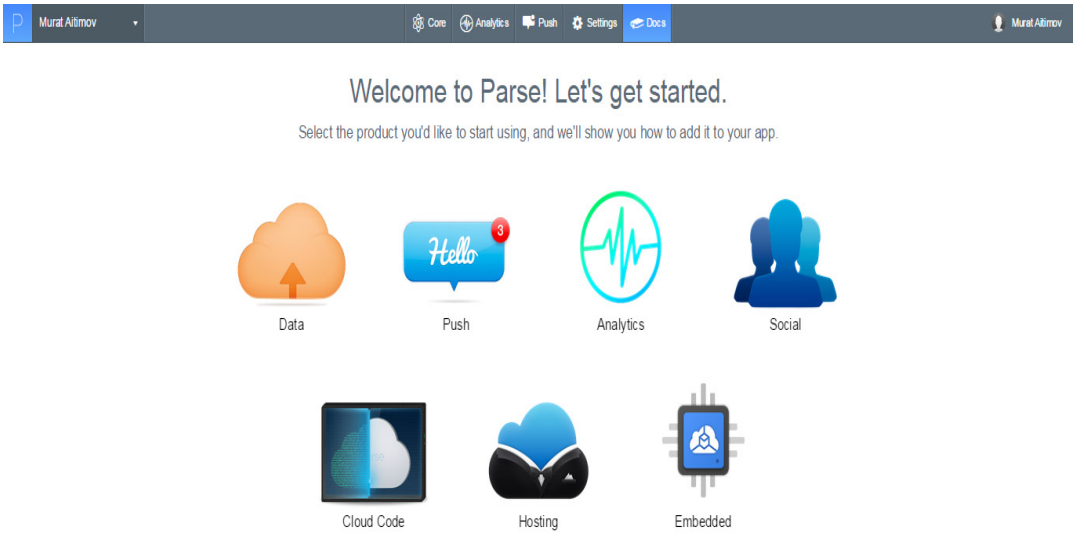


Fig. 6. The first page of Parse Cloud.

To start collecting and to build database, one must register on the website https://parse.com/ (see Fig. 6.). In our case, the login Murat Aitimov and as a class the “system” was created.

Next step is adding the columns where the data as temperature, radiation, etc. will be recorded (see Fig. 7.).

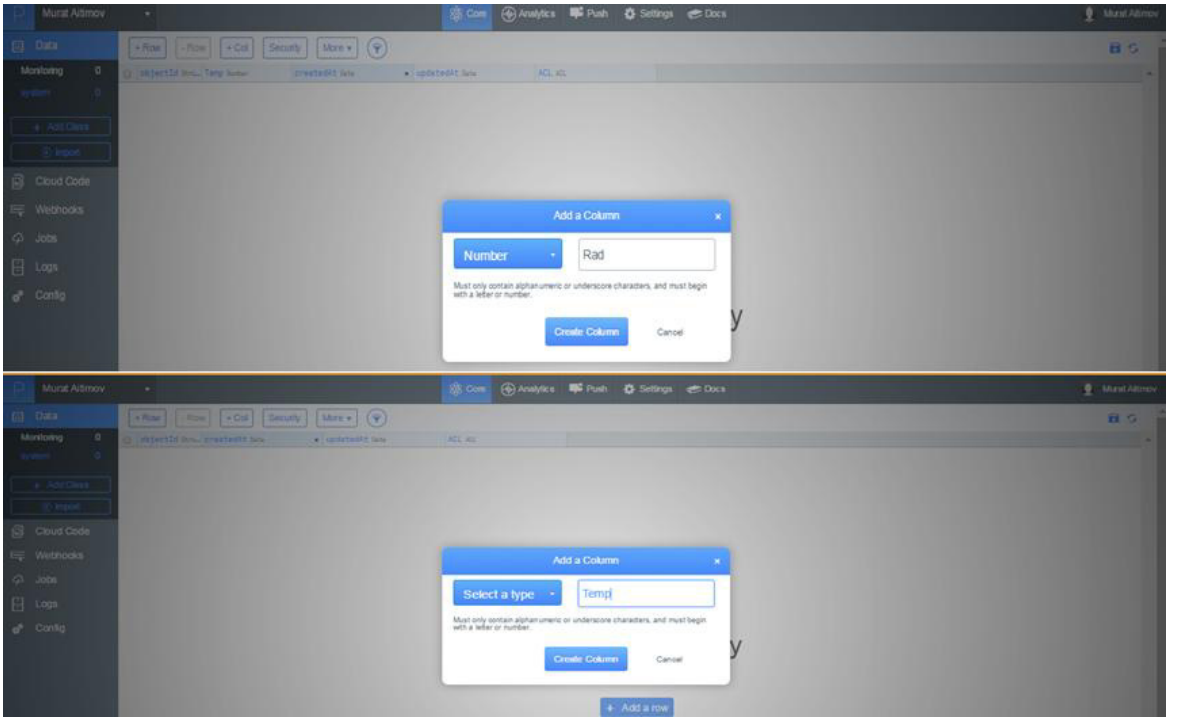


Fig. 7. Adding parameters.

## 6. Conclusions

Considering the proposed systems and device for monitoring the state of the environment is not difficult to imagine the complexity and ease of implementation of the main system, as well as the easiness of collecting the data and storing it in the cloud. Analyzing the data, we can describe the state of the environment at a specific time. Through the use of mobile applications the monitoring and analysis is greatly simplified.

Practical application in social life can be represented as follows: suppose that the stadium for football training of students is located in downtown, thanks to the monitoring system in real time, one can determine the level of carbon dioxide or toxic substances in the air, before the start of trainings. Also the developed EM IS can be used to prevent the occurrence of complications in humans exposed to elevated or reduced pressure (monitored pressure), asthma or allergies to certain gases in the air (air monitoring), etc.

Developed IS is one of the good practical examples for students, robotic and information systems engineers and developers, and for simple users. Considered EM system is developed for students, lovers of design of systems and devices, as an example of practical implementation, with a view to its improvement in the future. In addition in our EM we applied free cloud-based service for the Android applications, called Parse.

Ease of control and coordination of the individual blocks useful, because user may sequentially add or turn of some blocks, also user can disable some functions as temperature, pressure, etc.

In this paper we focus on the collection and analysis of data using mobile applications. In the future it is planned to develop more efficient control and management model for EM.

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